INEL-95/0585
Revision 7

Field Sampling Plan for Post-Record of Decision Monitoring for the Central Facilities Area Landfills I, II, and III under Operable Unit 4-12

September 2005

Idaho Cleanup Project

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September 2005

Idaho Cleanup Project
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
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ABSTRACT

The purpose of this document is to direct sampling efforts in support of monitoring activities for Operable Unit 4-12 Central Facilities Area Landfills I, II, and III and to describe the number and type of samples, sample locations, and analyses to be performed. In addition, monitoring of four wells south of the Central Facilities Area is also included in this plan as a matter of convenience for continued monitoring of other groundwater contamination sources at the Central Facilities Area.

The monitoring activities are conducted pursuant to the requirements delineated in the *Record of Decision—Declaration for Central Facilities Area Landfill I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)*. Part of the remedy stated in the Record of Decision included installation of a native soil cover over each landfill to mitigate infiltration of surface water and, consequently, to mitigate infiltration of potential contaminants to the groundwater. Environmental monitoring is designed to monitor and report on the remedy's effectiveness.

Data obtained as a result of this monitoring effort are used to evaluate the effectiveness of the landfill covers and to monitor for other potential contaminants that might be present in the groundwater from previous activities at the Central Facilities Area.

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ACRONYMS

CFA	Central Facilities Area
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
DAR	Document Action Request
DQO	data quality objective
DR	decision rule
DS	decision statement
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
FTL	field team leader
HASP	health and safety plan
ID	identification
IDAPA	Idaho Administrative Procedures Act
INL	Idaho National Laboratory
MCL	maximum contaminant level
MCP	management control procedure
NAT	neutron-access tube
PQL	practical quantitation limit
PSQ	principal study question
QA	quality assurance
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SRPA	Snake River Plain Aquifer

TAL	target analyte list
TDR	time-domain reflectometry
USGS	United States Geological Survey
VOC	volatile organic compound
WAG	waste area group
WGS	Waste Generator Services

Field Sampling Plan for Post-Record of Decision Monitoring for the Central Facilities Area Landfills I, II, and III under Operable Unit 4-12

1. INTRODUCTION

The activities described in this Field Sampling Plan (FSP) support the monitoring and sampling efforts for Central Facilities Area (CFA) Landfills I, II, and III and associated areas, which are part of Operable Unit 4-12, Waste Area Group (WAG) 4 at the Idaho National Laboratory (INL).

The monitoring and sampling activities are conducted pursuant to the requirements delineated in the *Record of Decision—Declaration for Central Facilities Area Landfill I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)* (DOE-ID 1995). Part of the Record of Decision selected remedy included installation of a native soil cover over each landfill to mitigate infiltration of surface water and, consequently, to mitigate infiltration of potential contaminants to the groundwater. The environmental monitoring is designed to monitor and report on the remedy's effectiveness as well as monitor and sample for other potential contaminants that resulted from previous facility activities. In addition, the *Final Comprehensive Record of Decision for Central Facilities Area Operable Unit 4-13* (DOE-ID 2000) requires that nitrate concentrations continue to be monitored under this Operable Unit 4-12 monitoring plan because of elevated levels that have been observed in two wells downgradient of CFA.

This FSP has been prepared in accordance with the appropriate INL management control procedures (MCPs) and the U.S. Environmental Protection Agency (EPA) guidance documents on the preparation of Sampling and Analysis Plans (SAPs). The Quality Assurance Project Plan (QAPjP) (DOE-ID 2004) describes the processes and programs for ensuring that the data generated will be suitable for their intended use. Modifications to this FSP include revisions to the original FSP through various Document Action Requests (DARs) (Form 412.11) as well as revisions and modifications that resulted from recommendations pertaining to sampling frequency, schedule, and long-term plans for the monitoring and sampling delineated in the *Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002).

1.1 Purpose and Scope

The purpose of this FSP is to guide the field team in the collection of environmental monitoring and sampling information. The data needs and monitoring objectives are discussed in detail in the *Post Record of Decision Monitoring Work Plan for the Central Facilities Area Landfills I, II, and II Operable Unit 4-12* (INEL 2003). The scope of the monitoring includes the following:

- Sampling groundwater from wells located near the CFA landfills and south of CFA
- Measuring water levels in monitoring wells
- Sampling soil gas through a series of soil-gas sampling ports of varying depths from five boreholes and two monitoring wells adjacent to the landfills
- Monitoring moisture content in the soil on and adjacent to the landfills by using neutron-access tubes (NATs) adjacent to the landfills and using time-domain reflectometry (TDR) arrays.

1.2 Background

The INL occupies 890 mi^2 of the northwestern portion of the Eastern Snake River Plain (see Figure 1-1) and is located 42 mi west of Idaho Falls, Idaho. Details regarding the INL's historical and geological information, as well as information relevant to the history, enforcement actions, and site characteristics of the CFA and the CFA landfills, is provided in the *Record of Decision—Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)* (DOE-ID 1995).

1.3 Site Description and Characteristics of the Central Facilities Area

A physical description of the CFA landfills and landfill waste is provided in Section 1 of the *Remedial Design/Remedial Action Work Plan for Central Facilities Area Landfills I, II, and III Native Soil Cover Project, Operable Unit 4-12* (DOE-ID 1996). The nature and extent of the contaminants of concern are summarized in the *Record of Decision—Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)* (DOE-ID 1995). Greater detail concerning the site characteristics can be found in the *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory—Volume I: Remedial Investigation* (Keck et al. 1995) and the *Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory—Volume II: Feasibility Study* (Dames & Moore 1995).

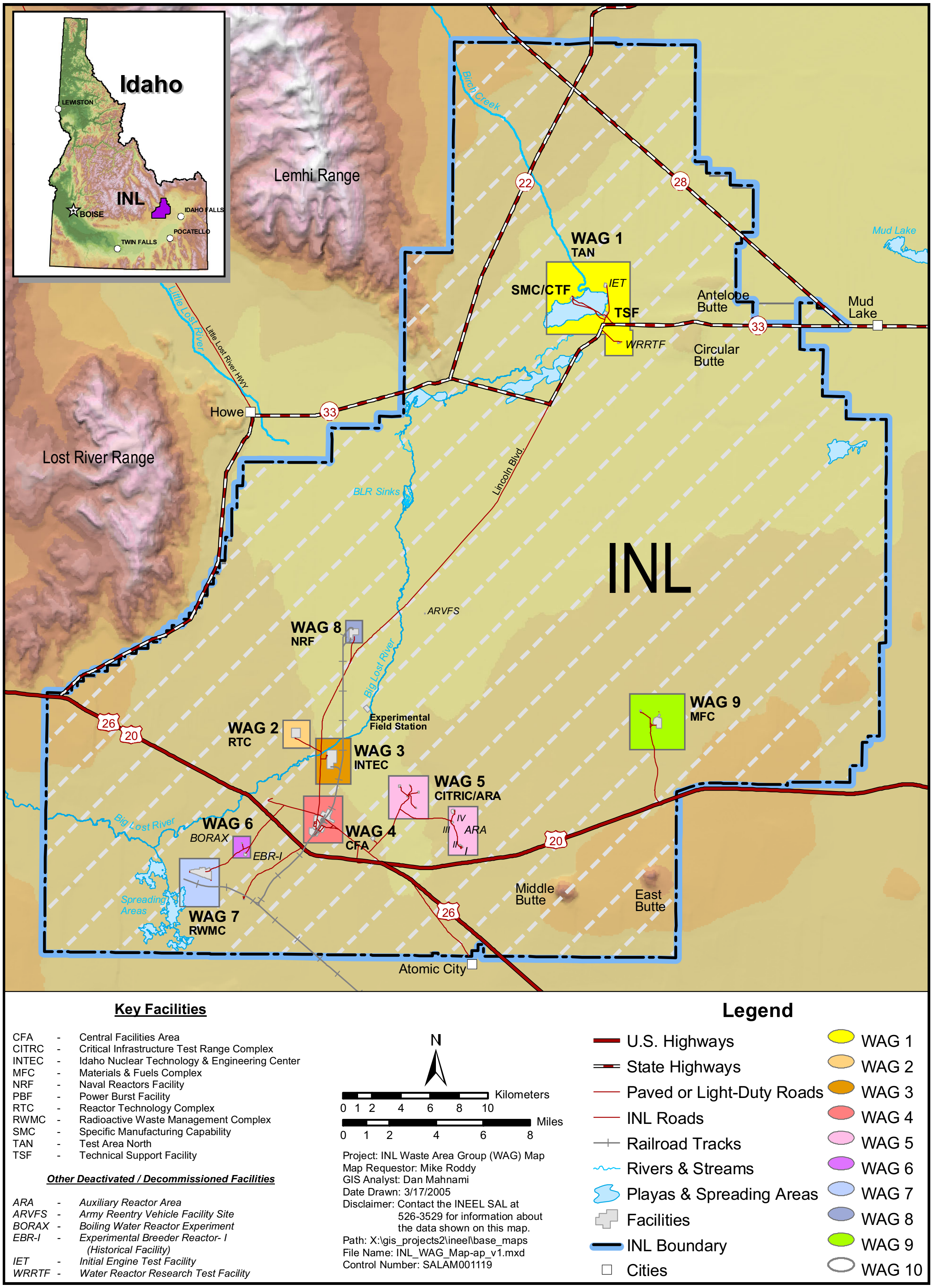

Figure 1-1. Map of the Idaho National Laboratory.

2. DATA NEEDS

This section identifies the data needs required for conducting the proposed sampling in support of the CFA landfill monitoring activities. Data needs and data quality objectives (DQOs) are defined in the following subsections.

Data needs have been determined through the evaluation of existing data and the projection of data requirements anticipated for analysis of samples and measurements collected in support of the CFA landfill monitoring effort. The DQOs have been developed following the process outlined in the *Guidance for the Data Quality Objectives Process* (EPA 1994).

2.1 Problem Statement

The objective of DQO Step 1 is to use relevant information to clearly and concisely state the problem to be resolved. The primary concern with the landfills is whether the native soil covers are properly mitigating the infiltration of moisture through them. Moisture can infiltrate the landfill covers and, in doing so, carry any contaminants that might be present to the Snake River Plain Aquifer (SRPA) underlying the INL site. Another concern, as described in the *Central Facilities Area Landfill Five-Year Review Supporting Documentation* (DOE-ID 2002), is that volatile organic compounds (VOCs) detected during soil-gas monitoring appear to be increasing with time for some sample port depths. The problem statements associated with this DQO process step are as follows:

- **Problem Statement 1—Moisture Infiltration Monitoring:** Reduce the uncertainties regarding whether moisture from rainfall or spring run-off is infiltrating the native soil covers at a rate that would raise concern that contaminants could be carried to the SRPA.

- **Problem Statement 2—Vapor Contaminant Monitoring:** Ensure that the contaminant concentrations in the vadose zone do not increase to levels that will impact groundwater quality.

- **Problem Statement 3—Groundwater Contaminant Monitoring:** Detect contaminants that are leached from the CFA landfills into the groundwater.

2.2 Decision Identification

The goal of DQO Step 2 is to define the questions that the study will attempt to resolve and to identify the alternative actions that may be taken based on the outcome of the study. Alternative actions are those that result from the resolution of the stated principal study questions (PSQs). The types of alternative actions considered depend on the answers to the PSQs. The PSQs and their corresponding alternative actions will then be joined to form decision statements (DSs). The PSQs and resulting DSs for CFA landfill monitoring are provided in Table 2-1.

2.3 Identify Inputs to the Decision

The purpose of DQO Step 3 is to identify the type of data needed to resolve each DS identified in DQO Step 2. These data may already exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limits [PQLs], precision, and accuracy) also are provided in this step for any new data that will be collected.

Table 2-1. Summary of data quality objective Step 2 information.

PSQ #1—Are the CFA landfill covers properly mitigating the infiltration of moisture into the underlying waste?
DS #1—Determine whether the covers are mitigating the rate of moisture infiltration into the underlying waste.
PSQ #2—Do subsurface moisture levels indicate that moisture might have infiltrated the landfill waste and subsequently provided a transport mechanism for contamination?
DS #2—Determine whether subsurface moisture levels indicate the possible transport of contamination from the landfills.
PSQ #3—Do contaminant trends in the subsurface indicate the possibility that contamination is migrating into the aquifer from the landfills?
DS #3—Determine whether the trend of contaminant concentrations in the subsurface indicates the possibility that contamination from the landfills is migrating toward the SRPA.
PSQ #4—Are any contaminant trends apparent in the SRPA that would indicate the possibility that contamination is migrating into the aquifer from either the landfills or perhaps another unidentified source?
DS #4—Determine whether the trend of contaminant concentrations in the SRPA indicates the possibility that contamination from the landfills is adversely affecting the aquifer or another unidentified source might be contributing to contaminant concentrations in the aquifer.
PSQ #5—If contaminants are present in the SRPA underlying the CFA landfills, what are the possible sources of contamination?
DS #5—Determine the direction of groundwater flow in order to identify possible sources of contamination if contaminants exceeding EPA groundwater quality standards or risk-based concentrations are detected in the SRPA.

CFA = Central Facilities Area
DS = decision statement
EPA = U.S. Environmental Protection Agency
PSQ = principal study question
SRPA = Snake River Plain Aquifer

2.3.1 Information Required to Resolve Decision Statements

Table 2-2 specifies the information (data) required to resolve each DS identified in Subsection 2.2 and identifies whether these data already exist. For the data that are identified as existing, the source references for the data have been provided with a qualitative assessment as to whether the data are of sufficient quality to resolve the corresponding DS. The qualitative assessment of the existing data was based on the evaluation of the corresponding quality control (QC) data (e.g., spikes, duplicates, and blanks), detection limits, and data collection methods.

Table 2-2. Required information and source references.

DS #	Measurement Variable	Required Data	Do Data Exist?	Source Reference	Sufficient Quality?	Additional Information Required?
1	Landfill moisture levels	Field measurements of moisture levels	Yes	*Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002)	Yes	Yes
2	Subsurface moisture levels	Field measurements of moisture levels	Yes	*Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002)	Yes	Yes
3	Subsurface chemical concentrations	Laboratory measurements of potential contaminants	Yes	*Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002)	Yes	Yes
4	SRPA chemical concentrations	Laboratory measurements of potential contaminants	Yes	*Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002)	Yes	Yes
5	Groundwater elevations	Field measurements of groundwater levels	Yes	*Central Facilities Area Landfills I, II, and III Five-Year Review Supporting Documentation* (DOE-ID 2002)	Yes	Yes

DS = decision statement
SRPA = Snake River Plain Aquifer

2.3.2 Basis for Setting the Action Level

The action level is the threshold value that provides the criterion for choosing between alternative actions. For DSs 1 and 2, moisture measurements will be collected to determine whether water is infiltrating the landfill covers or traveling to the subsurface, where it would possibly provide a transport mechanism for contaminants. For DS 3, the potential contaminants include VOCs. For DS 4, the potential contaminants include VOCs, anions, and metals. For DS 4, the EPA drinking water standards provide the basis for setting the contaminants' action levels. For DS 5, groundwater elevation measurements will be collected to determine the SRPA flow near the CFA landfills. The numerical values for the action levels are provided in DQO Step 5.

2.3.3 Computational and Survey/Analytical Methods

Table 2-3 identifies the DSs where existing data do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table 2-3 presents computational and/or surveying/sampling methods that could be used to obtain the required data. For DSs 1 and 2, field moisture will be measured to ascertain the moisture content of the soil immediately underlying the landfill covers and the subsurface beneath the landfills. The data will be used to determine whether the infiltration rate is decreasing but will not provide an infiltration rate by which the landfill cover performance can be estimated as being adequate. Soil moisture data will be used to estimate the current infiltration rate, probably as a range, through the covers and compared to the background NAT location to determine whether the landfill covers are reducing infiltration. The "adequacy" of the landfill covers will be based on water quality data collected from the SRPA. For DS 3, analytical data will be collected to determine the concentrations of VOCs in the subsurface underlying the landfills. These data will be used to determine the statistical trends for contaminants and the probability that contaminants will pose an unacceptable risk to the aquifer. For DS 4, analytical data will be collected to determine the concentrations of contaminants in the SRPA underlying the CFA landfills. As with the VOC data collected for DS 3, the groundwater data also will be used to determine whether a statistical trend exists. For DS 5, water elevations will be measured to evaluate groundwater elevation contours and flow direction.

Table 2-3. Information required for resolution of decision statements.

DS #	Measurement Variable	Required Data	Computational Methods	Survey/Analytical Methods
1	Moisture content	Moisture levels immediately underlying landfill covers	Compare moisture levels to historical data.	TDR arrays
2	Moisture content	Moisture levels in subsurface	Compare moisture levels to historical data.	NAT probes
3	Chemical	VOC concentrations in soil-gas samples	Obtain statistical trend of VOC concentrations over time.	Analytical laboratory determination of VOC concentrations in soil-gas samples
4	Chemical	Chemical concentrations in groundwater	Compare chemical concentrations to regulatory levels.	Analytical laboratory determination of chemical concentrations in groundwater
5	Water levels	Groundwater elevations	Flow direction over time	Field measurements of groundwater levels

DS = decision statement
NAT = neutron-access tube
TDR = time-domain reflectometry
VOC = volatile organic compound

2.3.4 Analytical Performance Requirements

Table 2-4 defines the analytical performance requirements for the data that need to be collected to resolve each DS. These performance requirements include PQL, precision, and accuracy requirements for each of the measurements and potential contaminants.

Table 2-4. Analytical performance requirements.

DS #	Analyte List	Survey/Analytical Method	Preliminary Action Level	PQL	Precision Requirement	Accuracy Requirement
1	Moisture content	TDR array	Not applicable	1%	± 20%	80–120
2	Moisture content	NAT probes	Not applicable	1%	± 5%	95–105
3	Soil Gas VOCs	EPA TO-14	Not applicable	100 ppbv[a]	± 25%	70–130
4	Groundwater VOCs (CLP TAL) Alkalinity Anions (chloride, fluoride, sulfate) Metals (CLP TAL) Nitrate/nitrite (as nitrogen)	 (see footnote b) (see footnote c) (see footnote d) CLP (see footnote e)	EPA and IDAPA regulatory levels	See QAPjP (DOE-ID 2004)	± 20%	80–120
5	Groundwater elevations	Measuring tape	Not applicable	Not applicable	± 0.01 ft	Not applicable

a. Actual quantitation limits are compound specific.
b. SW-846 Method 8260B
c. EPA Method 310.1, EPA Method 310.2, or SM 2320B
d. EPA Method 300 or SW-846 Method 9056
e. EPA Method 353.1, EPA Method 353.2, or SM 4500

CLP = Contract Laboratory Program
DS = decision statement
EPA = U.S. Environmental Protection Agency
IDAPA = Idaho Administrative Procedures Act
NAT = neutron-access tube
ppbv = parts per billion by volume
PQL = practical quantitation limit
QAPjP = Quality Assurance Project Plan
TAL = target analyte list
TDR = time-domain reflectometry
VOC = volatile organic compound

2.4 Study Boundaries

The primary objective of DQO Step 4 is to identify the population of interest, define the spatial and temporal boundaries that apply to each DS, define the scale of decision-making, and identify any practical constraints (hindrances or obstacles) that must be considered in the sampling design. Implementing this step ensures that the sampling design will result in the collection of data that accurately reflect the true condition of the site under investigation.

2.4.1 Geographic Boundaries

Limiting the geographic boundaries of the study area ensures that the investigation does not expand beyond the original scope of the task. This study will focus on the soil immediately beneath the CFA landfill covers, the subsurface underlying the CFA landfills, the SRPA beneath the CFA landfills, and the immediate area surrounding the CFA landfills. Based on review of the hydraulic data and groundwater contour maps, the selected wells will allow the potential migration of groundwater contaminants to be evaluated. Because of the elevated nitrate concentrations observed in the wells downgradient of the

CFA-04 mercury pond, the geographic boundary includes those areas that may be influenced by nitrates migrating to the SRPA from the pond.

2.4.2 Temporal Boundaries

The temporal boundary refers to the timeframe to which each DS applies (e.g., number of years) and when (e.g., season, time of day, and weather conditions) the data should optimally be collected. Temporal boundaries are important when contaminant concentration changes over time are significant. For the TDR arrays, data are collected continuously; therefore, no temporal boundary applies. For the NAT probes, data will be collected more frequently during times of higher moisture infiltration (i.e., winter snow pack and spring run-off). For the remainder of the year, data will be collected monthly. For soil-gas sample collection, sampling will occur in the early fall, because there is less moisture infiltration that can interfere with the soil-gas concentrations. Groundwater sampling and analysis will be performed at approximately the same time of year (i.e., September/October timeframe) in an effort to alleviate any effect that changes in groundwater levels due to snowmelt and run-off might have on the data collected. Groundwater-level measurements will be taken as part of the WAG 10 sitewide water-level measurement event in June to consolidate water-level measurement events and to ensure that the maximum number of wells is measured (DOE-ID 2005).

2.4.3 Scale of Decision-making

The scale of decision-making is defined by joining the population of interest and the geographic and temporal boundaries of the area under investigation. For the CFA landfill monitoring, the scale of decision-making is the same as the geographic boundary defined in Subsection 2.4.1.

2.4.4 Practical Constraints

Practical constraints include physical barriers, difficult sample matrices, high-radiation areas, or any other condition that will need to be taken into consideration in the design and scheduling of the sampling program. For the CFA landfill monitoring, there are no practical constraints to be considered.

2.5 Develop a Decision Rule

The purpose of DQO Step 5, initially, is to define the statistical parameter of interest (i.e., mean, 95% upper confidence level) that will be used for comparison against the action level. Table 2-5 summarizes the decision rules (DRs) for the five DSs provided in Section 2.2. These DRs summarize the attributes that the decision-maker needs to know about the sample population and how this knowledge will guide the selection of a course of action to solve the problem. Data and statistical trends will be reviewed annually.

2.6 Decision Error Limits

Because analytical data can only estimate the condition of the site under investigation, decisions that are made based on measurement data could be in erroneous (i.e., decision error). Consequently, the primary objective of DQO Step 5 is to determine which DSs (if any) require a statistically based sample design. The purpose of determining the decision error limits is to specify the decision-maker's tolerable limits on decision errors, which are used to establish performance goals for the data collection design.

Table 2-5. Decision rules.

DS #	DR #	Decision Rule
1	1	**If** the moisture content for soil immediately underlying the CFA landfill covers significantly exceeds that historically experienced (i.e., post cover installation), **then** the source of the additional moisture will be investigated and the integrity of the covers will be verified. Otherwise, it will be concluded that the covers are functioning as designed.
2	2	**If** the moisture content in the subsurface underlying the CFA landfills significantly exceeds that historically experienced (i.e., post cover installation), **then** the source of the additional moisture will be investigated and the integrity of the covers will be verified. Otherwise, it will be concluded that the covers are functioning as designed.
3	3	**If** the VOC concentrations in the subsurface indicate a significant statistical upward trend, **then** the integrity of the covers will be verified. Otherwise, it will be concluded that the covers are functioning as designed.
4	4	**If** the concentration of a contaminant in any well sample indicates a statistical upward trend, **then** the source of the contamination will be investigated and the integrity of the covers will be verified. Otherwise, it will be concluded that the covers are functioning as designed.
5	5	Not applicable

CFA = Central Facilities Area
DR = decision rule
DS = decision statement
VOC = volatile organic compound

Tolerable error limits assist in the development of sampling designs to ensure that the spatial variability and sampling frequency are within specified limits. However, the sampling design for the CFA landfill monitoring is determined by the current locations of TDR arrays, NAT probe holes, soil-gas sampling vapor ports, and monitoring wells. The selection of these locations is based on professional judgment rather than statistics. Therefore, error limits are not used to determine sampling locations or frequency.

For DSs to be resolved using a nonstatistical design, there is no need to define the "gray region" or the tolerable limits on the decision error, since these only apply to statistical designs. For the CFA landfill monitoring, a 95% significance level will be used to determine whether a trend in the data exists. Given the level of significance, the following null hypothesis was developed:

Null Hypothesis—A significant positive trend in the data exists.

2.7 Optimize the Design

The objective of DQO Step 7 is to present alternative data collection designs that meet the minimum data quality requirements, as specified in DQO Steps 1 through 6. Then, a selection process is used to identify the most resource-effective data collection design that satisfies all of the data quality requirements. For DSs 1 and 2, the sampling design has been implemented, and no changes in that design are currently foreseen. The following subsections present the selected technology and sampling methods for resolving DSs 3 and 4. A summary of the proposed implementation design and the basis for the selected implementation design are also presented below.

2.7.1 Soil-gas and Groundwater Monitoring

Monitoring will be performed from the soil-gas vapor ports and groundwater-monitoring wells on an annual basis. Samples will be sent to an approved laboratory for analysis with full quality assurance/quality control (QA/QC) protocols. Field measurements will be used to ascertain groundwater elevations. Soil-gas monitoring will be continued until the regulatory agencies determine it is no longer necessary. The primary objective of the groundwater monitoring is to detect releases of contaminants from the landfills to the uppermost aquifer, in accordance with the requirements of 40 CFR 264.310 maximum contaminant levels (MCLs). Monitoring of the groundwater will continue until it is agreed upon with the regulatory agencies during a five-year review that the monitoring effort can cease.

2.7.2 Trend Analysis

The intent of the trend analysis is to determine whether the null hypothesis (a significant positive trend in the data exists) is true. Various statistical tests exist to determine whether a significant temporal trend exists in a given data set. Before any statistical treatment of the data, they will be reviewed to verify whether the data set is parametric. If the data are found to be parametric, then the simple linear regression described below will be used to test the null hypothesis. If the data are nonparametric, a different test (e.g., Mann-Kendall) will be used to determine whether a trend exists.

For simple linear regression, the statistical test of whether the slope is significantly different from zero is equivalent to testing whether the correlation coefficient is significantly different from zero. To perform the test, the correlation coefficient is first calculated as follows:

$$r = \frac{n\sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{\left(\left(n\sum_{i=1}^{n} X_i^2 - \left(\sum_{i=1}^{n} X_i\right)^2\right)\left(n\sum_{i=1}^{n} Y_i^2 - \left(\sum_{i=1}^{n} Y_i\right)^2\right)\right)^{1/2}} \tag{2-1}$$

where

r = correlation coefficient for a given analyte

X_i = the year of sample collection

Y_i = individual concentrations for a given analyte.

This correlation coefficient is then used to calculate the t-statistic (Equation 2-2), which is then compared to the critical value for $t_{1-\alpha/2}$ to determine whether there is a significant correlation between the two variables (in this case, an analyte's concentration versus time). Historical and current data sets will be combined to perform the trend analysis.

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}} \qquad (2\text{-}2)$$

where

t	=	the calculated t-test statistic
r	=	correlation coefficient for a given analyte calculated in Equation 2-1
n	=	the number of data points.

If the calculated t is greater than $t_{n-2,\ 1-\alpha}$ as obtained from a table of statistical t-values, then the null hypothesis is rejected, and it can be concluded that there is no significant positive statistical trend in the data. Conversely, if the calculated t is less than $t_{n-2,\ 1-\alpha}$ as obtained from a table of statistical t-values, then the null hypothesis is not rejected, and it can be concluded that there is a significant positive statistical trend in the data.

3. FIELD ACTIVITIES

The groundwater sampling, water-level measurement, soil-gas sampling, and moisture measurement activities are described in the following subsections. Additional details for each of the monitoring activities presented in this FSP are included in the *Post Record of Decision Monitoring Work Plan for the Central Facilities Area Landfills I, II, and III Operable Unit 4-12* (INEL 2003).

3.1 Groundwater Sampling Locations and Analytes

As described in Section 1, groundwater monitoring is conducted in order to (1) establish a baseline of potential contaminant concentrations in the aquifer against which future data could be compared, and (2) to ensure that drinking water standards are not exceeded in the SRPA due to migration of contaminants from the landfills.

3.1.1 Groundwater Monitoring Locations for the CFA Landfills

Groundwater samples will be collected from nine wells near the CFA landfills. Table 3-1 lists the wells being sampled and the sampling rationale for each, and the location of each well is shown on Figure 3-1. Groundwater sampling and analysis are conducted annually in October and November.

Table 3-1. Construction details for groundwater monitoring wells and sampling rationale.

Well Identification	Well Completion (depth below land surface in feet)	Pump Depth	Sampling Rationale
CFA landfill monitoring wells			
LF 2-08	Screened (485–495)	483	Downgradient from Landfill II
LF 2-09	Screened (469.6–497)	486	Downgradient from Landfill II
LF 2-11	Screened (484–499)	481	Upgradient from Landfill II
LF 3-08	Screened (500–510)	480	Downgradient from Landfills I and III[a]
LF 3-09	Screened (490–500)	486	Downgradient from Landfills I and III[a]
LF 3-10	Screened (481–501)	494	Adjacent to Landfill III
USGS-128	Open hole (457–615)	523	Upgradient from Landfills I and III
CFA-1931	Screened (480–520)	507	Downgradient of Landfill II
CFA-1932	Screened (485–525)	509	Downgradient of Landfill I
CFA monitoring wells			
USGS-083	Open hole (516–752)	606	Further downgradient from CFA
CFA-MON-A-001	Screened (488–518)	514	Downgradient from CFA
CFA-MON-A-002	Screened (488–518)	516	Downgradient from CFA
CFA-MON-A-003	Screened (488–518)	508	Downgradient from CFA

a. These wells are crossgradient from parts of Landfill I and downgradient from other parts.

CFA = Central Facilities Area
USGS = United States Geological Survey

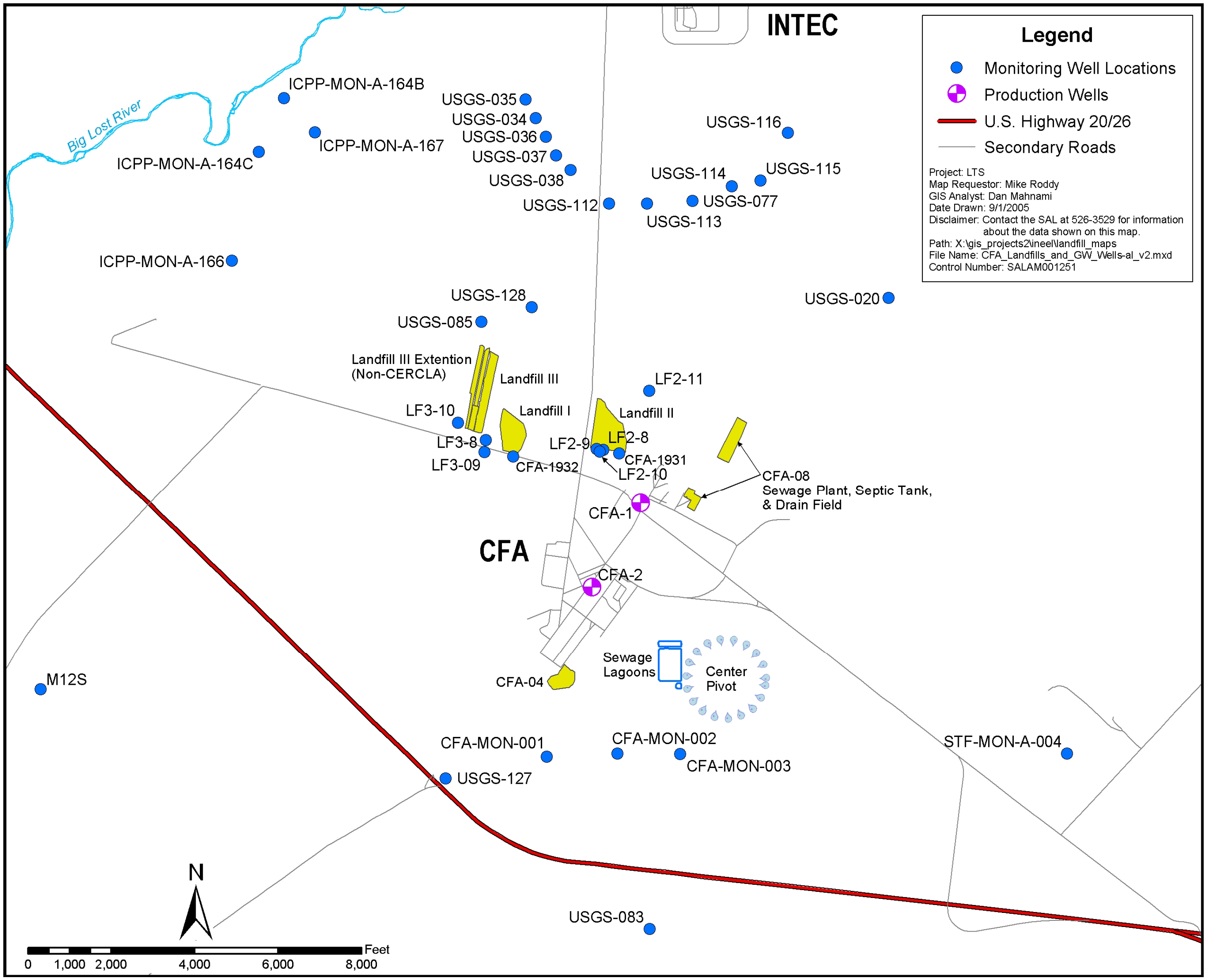

Figure 3-1. Map showing locations of monitoring wells for sampling and water-level measurement.

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The groundwater samples will be analyzed for VOCs, metals, anions, alkalinity, and nitrate/nitrite as nitrogen. Unfiltered samples will be collected for metals unless there is an increasing trend of metals or increased indicators of turbidity. Dichlorodifluoromethane (Freon-12) and trichlorofluoromethane (Freon-11) also will be analyzed in the groundwater, because both occurred frequently in the vapor samples. These constituents will be reported as part of the VOC analysis. Details of the groundwater sample collection requirements and sample preservation will be in the laboratory statement of work.

3.1.2 Groundwater Monitoring Locations South of CFA

Four wells, CFA-MON-A-001, CFA-MON-A-002, CFA-MON-A-003, and USGS-083, south of CFA are monitoring nitrate contamination. These wells are not being monitored for purposes of the landfill remedy. The nitrate contamination is believed to have originated from the former CFA-04 dry pond, not the landfills (ICP 2004). This monitoring is included in this FSP as a matter of convenience for the continued monitoring of other CFA groundwater contamination sources. Groundwater samples from these wells will be analyzed for the same list of contaminants as the CFA landfill wells.

3.2 Water-level Monitoring

Groundwater-level measurements will be obtained for the 13 wells that are routinely sampled and from 21 other wells located near the CFA landfills (see Table 3-2 and Figure 3-2). The water-level measurement event is scheduled to coincide with the sitewide groundwater-level measurements scheduled for June. Water levels also will be measured before sampling a well. The water-level contours for the CFA area from June 2004 are shown on Figure 3-3.

3.3 Soil-gas Monitoring

Soil-gas samples will be collected from four intervals in the five gas sampling boreholes and from two intervals in Wells CFA-1931 and -1932. The locations of the five soil-gas boreholes are shown in Figure 3-2, and the locations of CFA-1931 and -1932 are shown on Figure 3-1. The gas-sampling ports at each location are designed to sample soil gases from discrete depths. In the four soil-gas sampling boreholes, one shallow sampling port was placed within the surficial sediments at a depth of approximately 13 ft; the second sampling port was placed in basalt at a depth of approximately 38 ft above the shallow interbed, which is located approximately 40 to 60 ft below land surface; and two deep sampling ports were placed below the shallow interbed, with perforated sections vertically separated by approximately 30 ft at depths of approximately 78 and 108 ft. The actual sampling depths for the gas-sampling ports are given in Table 3-3. The perforated sections of the deep sampling ports in the two monitoring wells were located adjacent to fracture zones with one port located just above the water table.

Recommendations made in the *Central Facilities Area Landfills I, II, and III Five-Year Supporting Documentation* (DOE-ID 2002) specify that soil-gas should continue to be sampled on an annual basis until VOC concentrations demonstrate a significant and consistent downward trend in the analytical results. The report further recommends that the soil-gas sampling should take place in the early fall (i.e., September), because there is less moisture infiltration that would interfere with the soil-gas concentrations.

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Table 3-2. Water-level elevation measurement well.

Groundwater Sampling and Water-level Measurement Wells	Water-level Measurement Wells	
LF 2-08	STF-MON-A-004	USGS-112
LF 2-09	LF2-10	USGS-113
LF 2-11	USGS-020	USGS-114
LF 3-08	USGS-034	USGS-115
LF 3-09	USGS-035	USGS-116
LF 3-10	USGS-036	USGS-127
CFA-MON-A-001	USGS-037	M12S
CFA-MON-A-002	USGS-038	ICPP-MON-A-164B
CFA-MON-A-003	USGS-077	ICPP-MON-A-164C
USGS-083	USGS-085	ICPP-MON-A-166
USGS-128		ICPP-MON-A-167
CFA-1931		
CFA-1932		

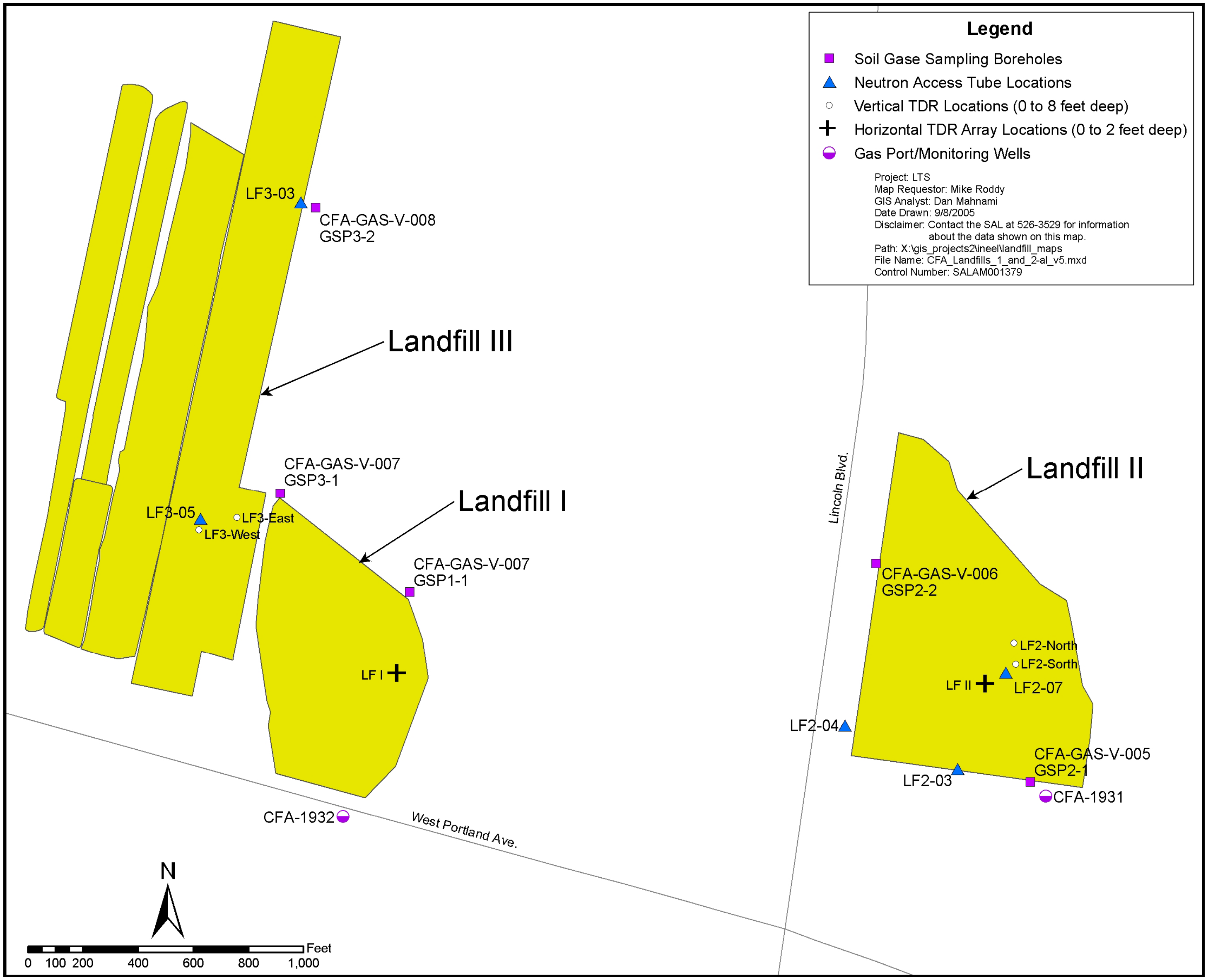

Figure 3-2. Map of time-domain reflectometry arrays, neutron-probe access tubes, and soil-gas sampling boreholes.

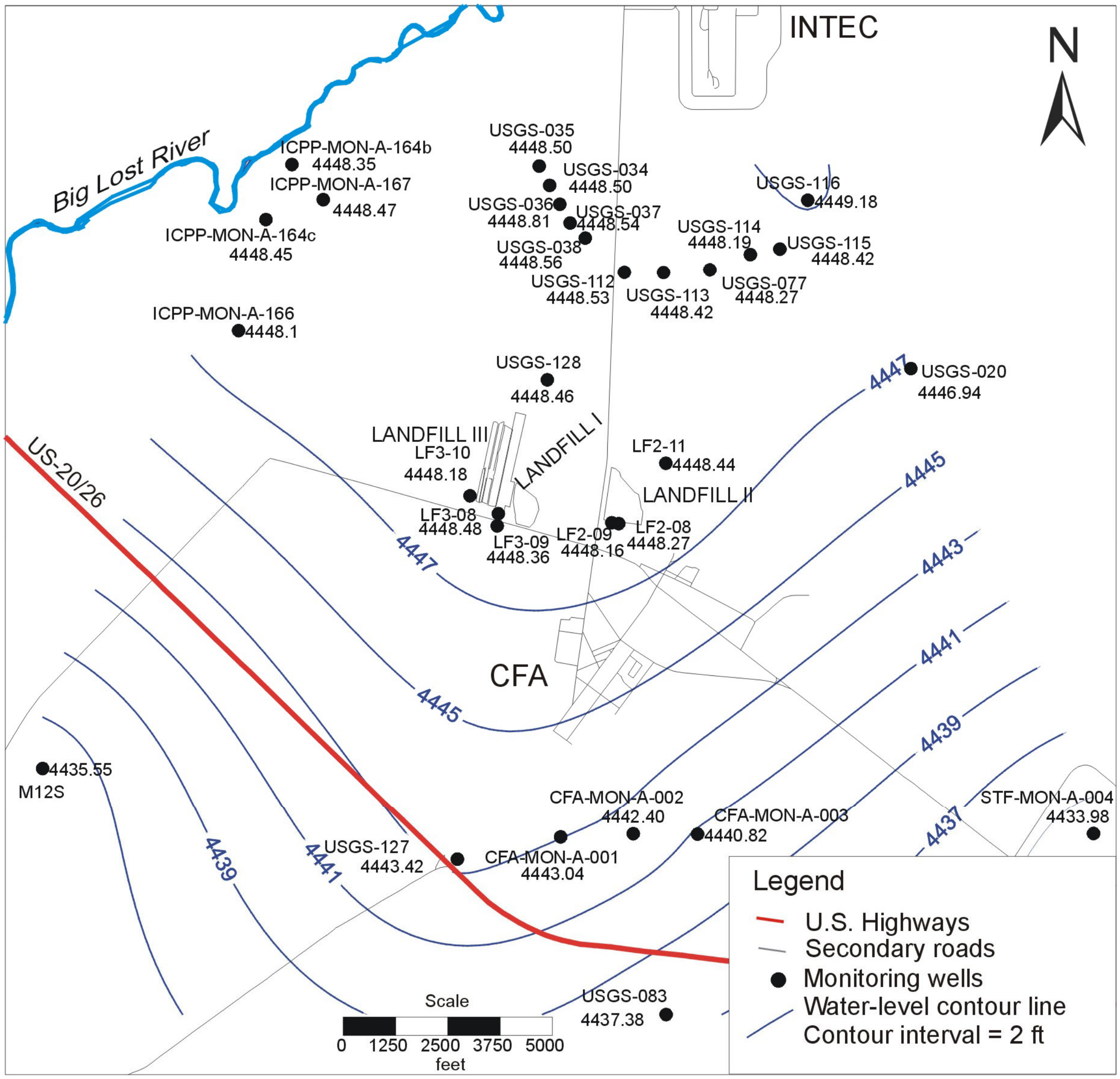

Figure 3-3. Water-level contour plot for the Central Facilities Area from June 2004.

Table 3-3. Sampling depths for soil-gas boreholes and monitoring wells with gas sampling ports.

Location	Gas Sampling Intervals (feet below ground surface)			
Soil-gas Boreholes				
Nominal depth[a]	12.5	37.5	77.5	107.5
GSP1-1	8.5–11.5	43–46	64–67	95–98
GSP2-1	11–14	41–46	66–69	94–97
GSP2-2	15–18	39–42	64–67	90–99
GSP3-1	11–14	40–43	74–77	101–104
GSP3-2	9–12	44–47	68–71	101–104
Monitoring Wells with gas sampling ports				
CFA-1931	295–300	470–475		
CFA-1932	255–260	465–470		

a. The nominal depth is the depth proposed in the work plan (DOE-ID 1996) and is used for sample identification.

3.4 Moisture Monitoring

The locations of the four vertical TDR systems and the five NATs installed at CFA Landfills II and III are shown in Figure 3-2. The two vertical TDR arrays located on Landfill II are near NAT LF2-07. NAT LF2-07 is located on Landfill II, and LF2-03 is located on the edge of Landfill II. LF2-04 is located near Landfill II and is used for monitoring infiltration and recharge in native soil or background conditions. The two vertical TDRs on Landfill III are installed through the cover near NAT LF3-05. NAT LF3-3 is located on the edge of Landfill III.

4. SAMPLING PROCEDURES

Procedures for groundwater sampling and soil-gas sampling are described in the following subsections. The procedures for neutron probe and TDR monitoring also are described.

4.1 Groundwater Sampling Equipment and Procedures

The groundwater monitoring wells listed in Table 3-2 will be sampled for the constituents listed in Subsection 3.1. When possible, for efficiencies of field sampling activities and potential cost savings, sampling will be coordinated and sampled cooperatively with United States Geological Survey (USGS) groundwater sampling personnel. All groundwater sampling will be completed in accordance with the latest INL procedure for groundwater sampling.

4.1.1 Site Preparation

All required documentation and safety equipment will be assembled at the well sampling site, including radios, fire extinguishers, personal protective equipment, bottles, and accessories.

Before sampling, all sampling personnel are responsible for having read both the SAP and the corresponding health and safety plan (HASP), which is the *Health and Safety Plan for Long-Term Stewardship Sitewide Groundwater Monitoring* (ICP 2004). The field team leader (FTL) will perform a daily site briefing to discuss potential hazards and ensure that all personnel have the required training. The FTL will assign a team member to maintain document control and will note this appointment in the WAG 10 groundwater sample logbook in accordance with the requirements in the latest INL procedure that delineates logbook practices for environmental restoration and deactivation, decontamination, and decommissioning projects.

All sampling equipment that contacts the sample media will be cleaned in accordance with the requirements stated in the latest INL procedure for decontaminating sampling equipment. The exception to this will be dedicated, submersible sampling pumps. Sampling manifolds either will be decontaminated before bringing them to the field or decontaminated after use in each well before using them on another well.

4.1.2 Field Measurements

Initially, the field team will establish the work control zone as indicated in the pending HASP and will measure the depth to water. The water level data are used to determine the volume of water that must be purged before sampling. The field team will measure water levels to 0.01 ft at each well before purging, using an electronic measuring device. A postsampling water-level measurement is not required. In addition to the water-level measurement, the field team will measure the height from the depth-to-water measuring point to the top of the well casing and the stickup of the well casing, either above the ground surface or the well pad.

Table 3-2 shows the wells that will be sampled. This table supplies the field team with the necessary well completion data. The field team will calculate the purge volume based on the current water level and will record all calculations on the well purging data form. The FTL will supply the field team with the approximate past purge volume as a crosscheck.

An inline flow meter may be attached to the sampling apparatus before purging to provide an accurate indicator of the pumping rate. If used, the portable inline flow meter will be attached downstream from the sampling port. The pre-purge flow meter reading will be recorded on the well purging data form so that the total volume purged can be recorded upon sample completion. If an in-line flow meter is not used, then the purge-water flow volume will be measured using a measured bucket and a watch to measure the approximate flow rate. This will measure the amount of time it takes to fill a specific volume of the bucket (e.g., 1 or 5 gal).

4.2 Soil-gas Sample Collection Method

Soil-gas samples are collected into a Tedlar bag or SUMMA canister with a portable, battery-powered vacuum pump, as required by the latest INL technical procedure. The container will be prepared with a waterproof, adhesive label and will identify the sampling port from which the sample was collected. One or more coolers will be used to store and transport the soil-gas vapor sample collection containers.

Before collecting a sample, the sampler will ensure that all sampling port valves are closed and that the apparatus is purged with in situ soil-gas only. No nitrogen purge will be performed. Samples are then collected, packaged, and shipped to the laboratory for analysis. All five borehole and two monitoring well sampling locations should be sampled on the same day. The soil-gas samples are analyzed for VOCs, including methane. After sample collection, the sampler shall ensure that the monitoring ports are closed and sealed to prevent barometric pumping (sucking and blowing) of these sampling points between sampling events due to pressure changes from daily fluctuations and weather fronts.

Field blank samples will be collected in a Tedlar bag or a SUMMA canister during each day's field activities. The field control samples will be collected by drawing pre-purified nitrogen or filtered ambient air through the sampling apparatus with the sample probe attached. The field control samples will be labeled and analyzed in the same manner and for the same constituents as the actual soil-gas samples. One field duplicate sample also will be collected for every 20 soil-gas samples collected.

4.3 Neutron Probe Monitoring

Before the start of each NAT probe logging, the latest neutron logs will be examined for evidence of standing water in the NATs. A water level e-line will then be lowered into the NAT to check for standing water. The water level e-line will be removed from the NAT before lowering the neutron probe into the NAT. If standing water is found in the NAT, the water level e-line will be decontaminated and the neutron probe will not be lowered into the standing water. If standing water is encountered, then it will be removed either by bailing or using a peristaltic pump. Should one of these probes be lowered into the water, electronic parts of the probe must be unscrewed and dried.

Readings will be taken from the NATs with the neutron probe in accordance with the instructions in the latest INL procedure for neutron probe logging. Calibration of the neutron probe in accordance with resident procedures shall be verified before obtaining the readings. The process will be repeated at 1-ft intervals in each NAT with all readings of 16-second duration. After logging the data from the NATs, the data will be downloaded to a portable computer or transcribed into a spreadsheet. If the neutron probe is downloaded to a computer, then a portable, alternating current generator should power the neutron probe during the download to avoid a significant drain on the probe's batteries.

Previously, monitoring of NAT probes was performed on a monthly basis, except during the late winter and early spring when the potential effects of snowmelt on the moisture infiltration in landfill areas need more frequent monitoring. Consequently, the NATs are monitored twice a month, if needed, during the months of January, February, March, and April. If a thaw does not occur in January or February, then monitoring will be performed once rather than twice during the month. During the remainder of the year, the NATs are monitored monthly.

4.4 Time-domain Reflectometry Monitoring

The readings, which are collected by the TDR monitoring equipment, are collected by cell phone connection to a computer in Idaho Falls, Idaho. The data are then available for the operator to review, enter the TDR array readings into the database plots, plot the data to observe trends of results, and prepare the data for inclusion in the annual monitoring reports for the landfills and the general CFA. The data from the TDR arrays are typically downloaded and compiled on a weekly basis.

5. SAMPLE IDENTIFICATION

A systematic 10-character sample identification (ID) code will be used to uniquely identify all samples. The uniqueness of the number is required for maintaining consistency and ensuring that no two samples are assigned the same ID code.

The first designator of the code, 4, refers to the sample originating from WAG 4. The second and third designators, **GW** or **SG**, refer to the sample being collected in support of either the groundwater or the soil-gas monitoring. The next three numbers designate the sequential sample number for the project. A two-character set (i.e., 01, 02) will then be used to designate field duplicate samples. The last two characters refer to a particular analysis and bottle type. The SAP tables prepared prior to sampling will have specific bottle code designations.

For example, a groundwater monitoring sample collected to support a determination of the metal concentration of a target analyte list might be designated as 4GW01501C1, where (from left to right):

- **4** designates the sample as originating from WAG 4
- **GW** designates the sample as being collected in support of the groundwater monitoring
- **015** designates the sequential sample number
- **01** designates the type of sample (01 = original, 02 = field duplicate)
- **C1** designates Contract Laboratory Program metal analysis.

A SAP table/database will be used to record all pertinent information associated with each sample ID code.

5.1 Sampling and Analysis Plan Table/Database

5.1.1 Sampling and Analysis Plan Table

A SAP table format was developed to simplify the presentation of the sampling scheme for project personnel. The following subsections describe the information recorded in the SAP table/database, which will be prepared prior to sampling.

5.1.2 Sample Description

The sample description fields contain information relating to individual sample characteristics.

5.1.2.1 Sampling Activity. The sampling activity field contains the first six characters of the assigned sample number. The sample number in its entirety will be used to link information from other sources (e.g., field data and analytical data) to information located in the SAP table for data reporting, sample tracking, and completeness reporting. The analytical laboratory also will use the sample number to track and report analytical results.

5.1.2.2 Sample Type. Data in this field will be selected from the following:

- REG for a regular sample
- QC for a QC sample.

5.1.2.3 Sample Matrix. Data in this field will be selected from the following***:***

- Ground Water for groundwater samples
- Water for QA/QC water samples
- Soil Gas for soil-gas samples
- Ambient Air for QA/QC gas samples.

5.1.2.4 Collection Type. Data in this field will be selected from the following:

- GRAB for grab sample collection
- RNST for rinsate QA/QC samples
- DUP for field duplicate samples
- FBLK for field blank QA/QC samples
- TBLK for trip blank QA/QC samples.

5.1.2.5 Planned Date. This date is related to the planned start date of sample collection.

5.1.3 Sample Location Fields

This group of fields pinpoints the exact location for the sample in three-dimensional space, starting with the general AREA, narrowing the focus to an exact location geographically, and then specifying the DEPTH in the depth field.

5.1.3.1 Area. The AREA field identifies the general sample collection area. This field should contain the standard identifier for the INL area being sampled. For this investigation, samples are being collected from the CFA site, and the AREA field identifier will correspond to this site.

5.1.3.2 Type of Location. The TYPE OF LOCATION field supplies descriptive information about the exact sample location (such as aquifer well or borehole). Information in this field may overlap that in the LOCATION field, but the information is intended to add detail to the location.

5.1.3.3 Location. The LOCATION field may contain geographical coordinates, x-y coordinates, building numbers, or other location-identifying details, as well as program-specific information (such as borehole or well number). Data in this field normally will be subordinated to the AREA. This information is included on the labels generated by Sample and Analysis Management to aid sampling personnel.

5.1.3.4 Depth. The DEPTH of a sample location is the distance in feet from surface level or a range in feet from the surface.

5.1.4 Analysis Types

5.1.4.1 AT1–AT20. These fields indicate analysis types (e.g., radiological, chemical, and hydrological). Space is provided at the bottom of the form to clearly identify each type. A standard abbreviation also will be provided, if possible.

6. SAMPLE HANDLING, PACKAGING, AND SHIPPING

After groundwater samples are collected from the well, the sampler with the proper personal protective equipment will wipe the bottles to remove residual water and place them in the proper secured location until shipment. The sample custodian/shipper is responsible for ensuring that clear tape is placed over bottle labels, lids are checked for tightness, parafilm or equivalent (excluding volatile organic analysis samples) is placed around lids, and samples are bagged and properly packaged before shipment.

6.1 Field Screening

Groundwater samples have been collected periodically from INL wells for several decades. The laboratory results from all of these samples show that the samples are orders of magnitude below the U.S. Department of Transportation classification of radioactive material. Based on the process knowledge from the previous monitoring results, and the fact that all samples are collected from wells outside the facility fences, neither a field sample radiation screen nor a laboratory shipping screen will be required for these groundwater samples.

6.2 Sample Shipping

Samples will be transported in accordance with the regulations issued by the U.S. Department of Transportation (49 CFR 171 through 178). All samples will be packaged and transported to protect the integrity of the sample and prevent sample leakage.

Upon sample receipt, (according to their contract) the analytical laboratory personnel will perform the required quality assurance (QA) checks. The laboratory will communicate any discrepancies, such as broken samples or loss of chain-of-custody forms, to the project through the Sample and Analysis Management organization. The project will determine the appropriate corrective action on a case-by-case basis.

7. DOCUMENTATION

The elements of sample documentation covered in this section are described in additional detail in the QAPjP (DOE-ID 2004). The FTL, or designee, is responsible for controlling and maintaining all field documents and records and for ensuring that all required documents are submitted to the Administrative Record and Document Control coordinator.

The FTL will implement field changes requiring document revision in accordance with the latest revision of MCP-135, "Creating, Modifying, and Canceling Procedures and Other DMCS-Controlled Documents." All entries will be made in permanent, nonmeasurable black ink. All errors will be corrected by drawing a single line through the error and by entering the correct information. All corrections will be initialed and dated. However, the nature of sampling activities is such that small variations from the FSP are occasionally required to complete the task. These small deviations in the procedures are a one-time event for which a DAR is not necessary or desirable. These variations will be recorded in the WAG 4 groundwater sample logbook.

The serial number or ID number and disposition of all controlled documents (e.g., chain-of-custody forms) will be recorded in the Administrative Record and Document Control Logbook. If a document is lost, a new document will be completed. The loss of a document and an explanation of how the loss was rectified will be recorded in the Document Control Logbook. The serial number and disposition of all damaged or destroyed field documents also will be recorded. All voided and completed documents will be maintained in a project file until completion of the sampling events, at which time all logbooks, unused tags and labels, and chain-of-custody form copies will be submitted to the Sample and Analysis Management organization.

The list of necessary field documents required for sampling and monitoring include the following:

- Chain-of-custody forms
- WAG 4 Groundwater Sample Logbook, which includes shipping data, field instrument calibration/standardization, visitors sign-in, and FTL notes and comments
- QAPjP
- FSP
- HASP.

7.1 Field Documentation

7.1.1 Labels

A sample label will be used on each sample. Waterproof, gummed labels will be used. Labels may be affixed to sample containers before going to the field and completed on the actual sample date. The label will contain the sample collection time and date, preservation used, and type of analysis. Labels not in use will remain in the custody of the FTL or the FTL's designee.

7.1.2 Chain-of-Custody Forms

The chain-of-custody record is either an electronically generated or multiple-copy form that serves as a written record of sample handling. When a sample changes custody, those relinquishing and receiving the sample will sign a chain-of-custody record. Each change of possession will be documented. Thus, a written record tracking the sample handling will be established.

7.1.3 Logbook

The logbook applicable to this project will be the WAG 4 Groundwater Sample Logbook. The logbook will be used to record information necessary to interpret the analytical data in accordance with INL procedures. All information pertaining to sampling activities will be entered into this logbook. Entries will be dated and signed by the individual making the entry. The FTL or designee will check the logbook for accuracy and completeness.

The field team will use a separate sample-shipping logbook. Each sample will be entered in the logbook. This logbook will be used to record the sample ID number, collection date, shipping date, chain-of-custody number, cooler number, destination, sample shipping classification, name of shipper, and signature of person performing the QC check.

Each piece of equipment will be recorded in and will have a record of the standardization data in the WAG 4 Groundwater Sample Logbook. Team members will record information pertaining to the standardization of equipment used during this project.

The FTL will record a daily accounting of information related to this sampling project—including problems encountered, deviations from the SAP, and justification for field decisions—in the WAG 4 Groundwater Sample Logbook. This logbook also will double as a visitor's guest log.

Small deviations in the procedures that are a one-time event (for which a DAR is not necessary) will be recorded in the WAG 4 Groundwater Sample Logbook, as specified in Section 6.

7.1.4 Field Guidance Forms

The field team may use field guidance forms provided by the Sample and Analysis Management organization to facilitate sample container documentation and to organize field activities. Field guide forms contain information on the laboratory, analysis description, and task order statement of work analysis type number, minimum sample quantity, preservative requirements, container type, and allowable hold time.

7.1.5 Waste Management Guidance

For each well, the field team will be provided documentation regarding the approximate purge volume and the required waste management options for the purge volume.

7.2 Project Organization and Responsibility

Specific individuals will be assigned the following project positions during performance of the monitoring activities, as needed:

- Safety engineer
- FTL

- Radiological control technician
- Industrial hygienist
- Quality engineers
- Facility manager or representatives
- Sample and Analysis Management point of contact
- Administrative Record and Document Control coordinator
- Radiological engineer
- Occupational Medical Program representative
- Project manager
- Project engineer
- Task lead.

The HASP (ICP 2004) should be consulted for the overall organizational structure and specific personnel responsibilities, except for responsibilities of the Sample and Analysis Management point of contact and the Administrative Record and Document Control coordinator. In addition to responsibility descriptions, the HASP ensures the implementation of occupational health and safety requirements.

8. WASTE MINIMIZATION

As part of the prejob briefing, an emphasis will be placed on waste reduction methods, and personnel will be encouraged to continuously attempt to improve methods. No one will use, consume, spend, or expend equipment or materials thoughtlessly or carelessly. Practices to be instituted to support waste minimization include, but are not limited to, the following:

- Restriction of materials (especially hazardous materials) to those needed for performance of work
- Substitution of recyclable or burnable items for disposable items
- Reuse of items, when practical
- Segregation of contaminated from uncontaminated waste
- Segregation of reusable items (such as personal protective equipment and tools).

9. HANDLING AND DISPOSITION OF INVESTIGATION-DERIVED WASTE

All waste dispositioning will be coordinated with the appropriate Waste Generator Services (WGS) interface to ensure compliance with applicable waste storage, characterization, treatment, and disposal requirements. The WGS representative at CFA supplies the unique bar code serial number that is used for tracking. Tracking is accomplished in the Integrated Waste Tracking System.

The investigation-derived waste produced during sampling will include spent and unused sample material, personal protective equipment, miscellaneous sampling supplies, decontamination water, purge water, and samples. The WGS will provide a determination for the disposition of all waste (including purge water) that is based on a waste determination and disposition form.

Before sampling, the FTL will provide the field team with the waste determination and disposition form, which is generated by WGS, for each well. The waste determination and disposition form describes the required disposal option for the purge water. Purge water from a majority of wells to be sampled under this FSP is anticipated to be eligible for release to the ground surface. However, some well purge water and field material for particular wells might need to be containerized and disposed of according to WGS requirements. In addition, to help ensure that the purge volume is correct, the FTL will provide the samplers with the approximate volume of water that was purged from the well during a previous sampling round.

If the purged groundwater must be containerized because of contamination by radionuclides, chemicals, or regulatory restrictions, then containerization will be performed as long as a disposal option for the containerized purge water is available. If a purge water disposal option is not available, then WAG 4 will make a reasonable effort to find a disposal option before sampling the well or will reduce generation of this waste. For those sites that have specific purge water disposal restrictions, the groundwater monitoring and sampling team will try to coordinate sampling concurrently with other programs, WAGs, or the USGS to eliminate duplication and to provide for the most efficient and compliant management of purge water by those programs.

10. QUALITY

The objective of this investigation is to provide groundwater sample analytical data of sufficient quality and quantity to adequately monitor the CFA and CFA landfills. This FSP is used in conjunction with the QAPjP (DOE-ID 2004). These documents present the functional activities, organization, and QA/QC protocols necessary to achieve the specified DQOs. The QAPjP and the FSP together constitute the SAP for Operable Unit 4-12. Project-specific quality requirements not addressed in the QAPjP or elsewhere in this document are discussed in this section.

10.1 Quality Control Sampling

As outlined in the QAPjP (DOE-ID 2004), QA objectives are specified so that the data produced are of a known and sufficient quality for determining whether a risk to human health or the environment exists. Minimum precision, accuracy, and completeness measurements and minimum detection limits are quantitative objectives specified in the QAPjP. Representativeness and comparability are qualitative objectives. During the sampling discussed in this plan, field QC samples—including field blanks, duplicates, and trip blanks—will be collected and analyzed to evaluate the achievement of the precision and accuracy objectives specified in the QAPjP. Overall, both field and laboratory precision will be evaluated through the results of duplicate groundwater samples, equipment rinsates, and field blanks. The duplicate samples, equipment rinsates, and field blanks will be analyzed for the same suite of analytes as the regular groundwater samples. Trip blanks to be analyzed for VOCs will be included in each sample cooler containing VOC sample containers shipped to the laboratory.

Environmental analyses are critical, because decision-making based on inaccurate measurements or data of unknown quality can have significant economic and health consequences. To assess the accuracy and precision of the analytical laboratory, performance evaluation samples will be added, if available, for analysis with other groundwater sample-delivery groups. The performance evaluation samples are spiked with known concentrations of radionuclides or chemicals in levels similar to those expected in the actual samples. Laboratory accuracy and precision will be evaluated based on the analytical results of these performance evaluation samples.

10.2 Quality Assurance Objectives

As outlined in the QAPjP (DOE-ID 2004), QA objectives are specified to ensure that data produced are of a known and sufficient quality. Minimum precision, accuracy, completeness requirements, and detection limits are quantitative QA objectives specified in this plan or in the QAPjP. Representativeness and comparability are qualitative QA objectives.

10.2.1 Precision

Precision is a measure of the reproducibility of measurements under a given set of conditions. In the field, precision is affected by sample collection procedures and by the natural heterogeneity encountered in the environment. Overall, precision (field and laboratory) can be evaluated by the use of duplicate samples collected in the field. Typically, greater precision is required for analytes with very low action levels that are close to background concentrations.

Laboratory precision will be based on the use of laboratory-generated duplicate samples or matrix spike/matrix spike duplicate samples. Evaluation of laboratory precision will be performed during the method data validation process.

Field precision will be based on the analysis of collected field duplicate or split samples. For samples collected for laboratory analyses, a field duplicate will be collected at a minimum frequency of one in 20 environmental samples.

10.2.2 Accuracy

Accuracy is a measure of bias in a measurement system. Laboratory accuracy is demonstrated using laboratory control samples, blind QC samples, and matrix spikes. Evaluation of laboratory accuracy will be performed during the method data validation process. Sample handling, field contamination, and the sample matrix in the field affect overall accuracy. False positive or high-biased sample results will be assessed by evaluating results from field blanks, trip blanks, and equipment rinsates.

Field accuracy will only be determined for samples collected for laboratory analysis. The field screening instrumentation can only analyze the soil; it is not set up for the analysis of water samples. Therefore, accuracy of field instrumentation will be ensured by using appropriate calibration procedures and standards.

10.2.3 Detection Limits

Detection limits will meet or be less than the risk-based or decision-based concentrations for the contaminants of concern. Detection limits will be set as specified in the Sample and Analysis Management laboratory master task agreement statements of work, task order statements of work, and as described in the QAPjP (DOE-ID 2004).

10.2.4 Representativeness

Representativeness is a qualitative parameter that expresses the degree to which the sampling and analysis data accurately and precisely represent the characteristic of a population parameter being measured at a given sampling point or for a process or environmental condition. Representativeness will be evaluated by determining whether measurements are made and physical samples are collected in such a manner that the resulting data appropriately measure the media and phenomenon measured or studied. The comparison of all field and laboratory analytical data sets obtained throughout this remedial action will be used to ensure representativeness.

10.2.5 Comparability

Comparability is a qualitative characteristic that refers to the confidence with which one data set can be compared to another. At a minimum, comparable data must be obtained using unbiased sampling designs. If sampling designs are unbiased, the reasons for selecting another design should be well documented. Data comparability will be assessed through comparison of all data sets collected during this study for the following parameters:

- Data sets will contain the same variables of interest
- Units will be expressed in common metrics
- Similar analytical procedures and QA will be used to collect data
- Time of variable measurements will be similar
- Measuring devices will have similar detection limits

- Samples within data sets will be selected in a similar manner
- Number of observations will be the same order of magnitude.

10.2.6 Completeness

Completeness is a measure of the quantity of usable data collected during the field sampling activities. The QAPjP (DOE-ID 2004) requires that an overall completeness goal of 90% be achieved for noncritical samples. If critical parameters or samples are identified, a 100% completeness goal is specified. Critical data points are those sample locations or parameters for which valid data must be obtained in order for the sampling event to be considered complete. Given that this is a monitoring project, all field screening and laboratory data will be considered noncritical with a completeness goal of 90%.

11. DATA VALIDATION, REDUCTION, AND REPORTING

Method data validation is the process whereby analytical data are reviewed against set criteria to ensure that the results conform to the requirements of the analytical method and any other specified requirements. All laboratory-generated analytical data will be validated to Level B in accordance with INL procedures. Field-generated data will not be validated. The quality of the field-generated data will be ensured through adherence to established operating procedures and use of equipment calibration/ standardization, as appropriate.

12. REFERENCES

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49 CFR 171, 2005, “General Information, Regulations, and Definitions,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

49 CFR 172, 2005, “Hazardous Material Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements,” *Code of Federal Regulations,* Office of the Federal Register, July 2005.

49 CFR 173, 2005, “Shippers—General Requirements for Shipments and Packagings,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

49 CFR 174, 2005, “Carriage by Rail,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

49 CFR 175, 2005, “Carriage by Aircraft,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

49 CFR 176, 2005, “Carriage by Vessel,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

49 CFR 177, 2005, “Carriage by Pubic Highway,” *Code of Federal Regulations,* Office of the Federal Register, June 2005.

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